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PATENT ABSTRACTS OF JAPAN

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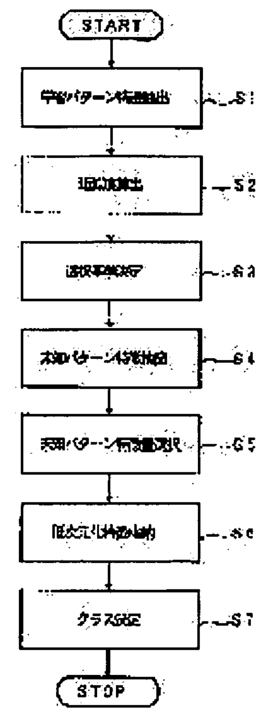
(72)Inventor : AKIYAMA TERUO
SAWAKI MINAKO

(54) FEATURE SELECTION METHOD

(57)Abstract:
PURPOSE: To provide the feature selection method capable of reducing the arithmetic amount of the product-sum operation of the distance required to decide the class to which the pattern belongs.
CONSTITUTION: The feature vector is extracted from plural learning patterns (step 1). The approximate degree is obtained from the statistic index (step 2). The selection reference of the feature quantity to be selected is decided (step 3). The feature vector of the unknown pattern is extracted (step 4). The feature vector of the unknown pattern which is extracted in the step 4 is selected based on the selected reference (step 5). The low dimensional feature vector is stored (step 6) and the class to which the unknown pattern belongs is decided (step 7).



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CLAIMS

[Claim(s)]

[Claim 1] When determining the class to which the pattern by which vectorial representation was carried out with two or more characteristic quantity belongs In the feature-selection method of determining the class to which an effective thing is chosen in each feature expressed by the vector, a feature vector is formed into a low dimension, and a pattern belongs Extract a feature vector from two or more training patterns, and it asks for the distribution of the value for every dimension of the feature vector about all or some of two or more patterns to which each class belongs. It asks for order of approximation with this distribution close [which] to a normal distribution with one or more statistical indexes. this order of approximation independently Or the selection criterion of the characteristic quantity which should be chosen by combining and using is determined. The feature-selection method characterized by extracting the feature vector of a strange pattern, choosing the feature vector of the extracted strange pattern based on this selection criterion, and storing the low feature vector of the obtained number of dimension.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the feature-selection method, in case it determines the class to which the pattern by which vectorial representation was especially carried out with two or more characteristic quantity belongs, chooses two or more features out of each feature expressed by the vector, and relates to the feature-selection method of determining a class by the vector of a low dimension.
[0002]
[Description of the Prior Art] In case the class to which the inputted strange pattern belongs conventionally is determined, the technique of compressing the number of dimension of the feature is known by performing principal component analysis using the covariance matrix of the feature vector obtained from two or more training patterns in process in which the distance of the dictionary and strange pattern which were created beforehand is found, performing space conversion, and using only a high order component with large characteristic value for distance calculation by the training pattern.
[0003] That is, when there is generally m-dimensional feature-vector x=(x1, x2, ..., xm) t, discriminant-function D(X) =(X-mu) t S-1(X-mu)-1n |S| of BEIZU is [0004].
[Equation 1]

$$D(X) = \sum_{m=1}^{n} (\phi_m{}^t (X-\mu))^2 / \lambda_m - 1_n |S|$$

[0005] It is equivalent, and by usually removing the low dimension component of the characteristic value lambda here, compression of the number of dimension of the feature in the space after conversion is aimed at, and the amount of operations is reduced. Here, for S, a covariance matrix and mu are [a characteristic vector and lambda of the mean vector and phi] characteristic value.
[0006]
[Problem(s) to be Solved by the Invention] However, in case the above-mentioned conventional technique performs dimension compression, for space conversion, as shown above (1), it needs to perform sum-of-products calculation, and has the problem that the amount of operations accompanying this calculation is large.
[0007] this invention was made in view of the above-mentioned point, solves the above-mentioned conventional trouble, and aims at offering the feature-selection method which can lessen the amount of operations of sum-of-products calculation of the distance calculation at the time of determining the class to which a pattern belongs.
[0008]
[Means for Solving the Problem] Drawing 1 is principle explanatory drawing of this invention.
[0009] When determining the class to which the pattern by which vectorial representation was carried out with two or more characteristic quantity belongs, this invention In the feature-selection method of determining the class to which an effective thing is chosen in each feature expressed by the vector, a feature vector is formed into a low dimension, and a pattern belongs Extract a feature vector from two or more training patterns (Step 1), and it asks for the distribution of the value for every dimension of the feature vector about all or some of two or more patterns belonging to each class. It asks for order of approximation with this distribution close [which] to a normal distribution with one or more statistical indexes (Step 2). order of approximation independently Or the selection criterion of the characteristic quantity which should be chosen by combining and using is determined (Step 3). The feature vector of the strange pattern which extracted the feature vector of a strange pattern (Step 4), and was extracted at Step 4 is chosen based on the selection criterion determined at Step 3 (Step 5). The low feature vector of the obtained number of dimension is stored (Step 6), and the class to which a strange pattern belongs is determined (Step 7).
[0010]
[Function] this invention performs distance calculation by the original feature space, not performing space conversion, when the distribution of the characteristic quantity for every dimension of a vector chooses only the thing near a normal distribution as an effective feature and uses the selected feature using the property in which the discernment precision by the discriminant function of BEIZU becomes the highest, when each characteristic quantity which constitutes a vector follows a normal distribution. Therefore, since the feature of the pattern expressed by the vector is chosen by the original feature space, as compared with the case where the feature number of dimension is compressed, the amount of operations decreases by space conversion.
[0011]
[Example] Hereafter, the example of this invention is explained with a drawing.
[0012] Drawing 2 shows the system configuration of one example of this invention.
[0013] The system shown in this drawing consists of the feature-extraction section 10, the degree calculation section 11 of approximation, the selection-criterion determination section 12, the feature-selection section 13, and the low dimension-ized

feature storing section 14.
[0014] Hereafter, operation of the above-mentioned composition is explained.
[0015] Drawing 3 is a flow chart for explaining the outline of operation of one example of this invention.
[0016] Step 10 First, the feature-extraction section 10 extracts characteristic quantity from two or more inputted training patterns, expresses it by the feature vector, and is inputted into the degree calculation section 11 of approximation.
[0017] The degree of approximation with the degree calculation section 11 of step 11 approximation close [the distribution of the characteristic quantity of each dimension expressed by the feature vector extracted at Step 11 / which] to a normal distribution is calculated using statistical indexes, such as skewness and kurtosis, for every characteristic quantity.
[0018] The step 12 selection-criterion determination section 12 determines independent or the selection criterion of the feature which should combine, should use and should be chosen for the order of approximation called for at Step 11. [two or more]
[0019] If a step 13 strange pattern is inputted into the feature-extraction section 10, characteristic quantity will be extracted, and it will express by the feature vector, and will input into the feature-selection section 13.
[0020] The step 14 feature-selection section 13 chooses the feature vector of a strange pattern based on the selection criterion determined in the selection-criterion determination section 12 in the feature vector extracted at Step 13.
[0021] The step 15 low dimension-ized feature storing section 14 stores the low feature vector of a number of dimension among the feature vectors of the strange pattern chosen in the feature-selection section 13.
[0022] The processing for determining the selection criterion in the selection-criterion determination section 12 here is explained. The kurtosis, the skewness, and N training pattern characteristic quantity vector quantity which were asked for the selection-criterion determination section 12 in the degree calculation section 11 of approximation are inputted. Here, it is the characteristic quantity vector of N training patterns inputted X1 = (x11, x12, ..., x1i, .., x1m)
X2 = (x21, x22, ..., x2i, .., x2m)
.. XN = (xN1, xN2, ..., xNi, .., xNm)
When it carries out, it can ask for the skewness and kurtosis of the i-th feature by the following formulas respectively.
[0023]
[Equation 2]

歪度：

$$A_i = (1/N) \sum_j \{ (x_{ij} - \mu_i) / S_i \}^3$$

尖度：

$$B_i = (1/N) \sum_j \{ (x_{ij} - \mu_i) / S_i \}^4$$

[0024] N shows the number of training patterns among the above-mentioned formulas, xij shows the i-th characteristic quantity of the j-th training pattern, and it is mui. The average of the i-th characteristic quantity of a training pattern is shown, and it is Si. The standard deviation of the i-th characteristic quantity of a training pattern is shown.
[0025] When each element of a vector follows a normal distribution, skewness is set to 0.0 and kurtosis is set to 3.0. a center [average] -- carrying out -- a distribution -- the left -- a value negative in skewness when distorted -- taking -- reverse -- the right -- it becomes a positive value in being distorted Moreover, it is known that acute [of the center of a distribution] will increase as kurtosis becomes large.
[0026] When skewness and kurtosis are given, the selection-criterion determination section 12 calculates the value used as the criteria for determining the selection feature based on these values as a selection criterion, and outputs the feature number to choose to the feature-selection section 13.
[0027] As criteria which choose the feature in the feature-selection section 13, it is the absolute value of a difference with the value of skewness [in / - normal distribution / for example,]. : a=|A-0.0| (3)
And absolute value of a difference with the value of the kurtosis in - normal distribution: b=|B-3.0| (4)
The feature of the fixed individual chosen from the direction with few values c which calculate them based on the following (5) formulas by carrying out linear combination of the values a and b in the feature of the fixed individual chosen from the smaller one of the sum of the ranking at the time of attaching ranking or (3), and (4) formulas from the one where the feature of the fixed individual chosen from the direction with few values at the time of ******(ing) and the value of a and b are smaller etc. can be considered.
[0028]
C=alphaa + betab (5)
Here, alpha and beta are parameters with a suitable value.
[0029] The feature-selection section 13 memorizes the selection feature number (selection criterion) determined by the selection-criterion determination section 12, and chooses the feature vector of the strange pattern actually inputted into the feature-extraction section 10 based on it. If the m-dimensional feature vector extracted from the strange pattern in the feature-extraction section 10 is inputted into this feature-selection section 13, the feature will be chosen in accordance with the selection criterion called for by the selection-criterion determination section 12, and a n-dimensional feature vector (m>n) will be outputted to the low dimension-ized feature storing section 14.
[0030] The low dimension-ized feature storing section 14 stores the feature of the strange data formed into the low dimension by doing in this way. For example, a 8-dimensional vector as shown below is inputted, and it is Xin. = (x1, x2, x3, x4, x5, x6, x7, and x8)
Xout =(x1 ,x2 ,x5 ,x8)
When memorizing in the feature-selection section 13 as a feature which 1, 2, and the 5 or 8th feature should choose, the

4-dimensional feature is outputted to the low dimension-ized feature storing section 14.
[0031] The low dimension-ized feature storing section 14 stores the feature (x1, x2, x5, and x8).
[0032] In addition, when a new training pattern is given, the feature can always be chosen in the optimal state by performing re-calculation of kurtosis and skewness, and reconfiguration of the feature decision criteria (selection criterion).
[0033] As mentioned above, in accordance with a selection criterion, an effective thing is chosen from the features expressed by the vector of the inputted strange pattern, and the class to which this is formed into a low dimension and a strange pattern belongs is determined.
[0034]
[Effect of the Invention] As mentioned above, since the feature used in case the class classification of the vector data expressed with two or more characteristic quantity is carried out according to this invention is chosen by the original feature space, it is not necessary to perform space conversion and the amount of the sum-of-products operation of the distance calculation at the time of determining the class to which a strange pattern belongs can be lessened.

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TECHNICAL FIELD

[Industrial Application] this invention relates to the feature-selection method, in case it determines the class to which the pattern by which vectorial representation was especially carried out with two or more characteristic quantity belongs, chooses two or more features out of each feature expressed by the vector, and relates to the feature-selection method of determining a class by the vector of a low dimension.

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PRIOR ART

[Description of the Prior Art] In case the class to which the inputted strange pattern belongs conventionally is determined, the technique of compressing the number of dimension of the feature is known by performing principal component analysis using the covariance matrix of the feature vector obtained from two or more training patterns in process in which the distance of the dictionary and strange pattern which were created beforehand is found, performing space conversion, and using only a high order component with large characteristic value for distance calculation by the training pattern.
[0003] That is, when there is generally m-dimensional feature-vector x=(x1, x2, ..., xm) t, discriminant-function D(X) =(X-mu) t S-1(X-mu)-1n |S| of BEIZU is. [0004]
[Equation 1]

$$D(X) = \sum_{m=1}^{n} (\phi_m{}^t (X-\mu))^2 / \lambda_m - 1_n |S|$$

[0005] It is equivalent, and by usually removing the low dimension component of the characteristic value lambda here, compression of the number of dimension of the feature in the space after conversion is aimed at, and the amount of operations is reduced. Here, for S, a covariance matrix and mu are [a characteristic vector and lambda of an average vector and phi] characteristic value.

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EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, since the feature used in case the class classification of the vector data expressed with two or more characteristic quantity is carried out according to this invention is chosen by the original feature space, it is not necessary to perform space conversion and the amount of the sum-of-products operation of the distance calculation at the time of determining the class to which a strange pattern belongs can be lessened.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in case the above-mentioned conventional technique performs dimension compression, for space conversion, as shown above (1), it needs to perform sum-of-products calculation, and has the problem that the amount of operations accompanying this calculation is large.
[0007] this invention was made in view of the above-mentioned point, solves the above-mentioned conventional trouble, and aims at offering the feature-selection method which can lessen the amount of operations of sum-of-products calculation of the distance calculation at the time of determining the class to which a pattern belongs.

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MEANS

[Means for Solving the Problem] Drawing 1 is principle explanatory drawing of this invention.
[0009] When determining the class to which the pattern by which vectorial representation was carried out with two or more characteristic quantity belongs, this invention In the feature-selection method of determining the class to which an effective thing is chosen in each feature expressed by the vector, a feature vector is formed into a low dimension, and a pattern belongs Extract a feature vector from two or more training patterns (Step 1), and it asks for the distribution of the value for every dimension of the feature vector about all or some of two or more patterns belonging to each class. It asks for order of approximation with this distribution close [which] to a normal distribution with one or more statistical indexes (Step 2). order of approximation independently Or the selection criterion of the characteristic quantity which should be chosen by combining and using is determined (Step 3). The feature vector of the strange pattern which extracted the feature vector of a strange pattern (Step 4), and was extracted at Step 4 is chosen based on the selection criterion determined at Step 3 (Step 5). The low feature vector of the obtained number of dimension is stored (Step 6), and the class to which a strange pattern belongs is determined (Step 7).

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OPERATION

[Function] this invention performs distance calculation by the original feature space, not performing space conversion, when the distribution of the characteristic quantity for every dimension of a vector chooses only the thing near a normal distribution as an effective feature and uses the selected feature using the property in which the discernment precision by the discriminant function of BEIZU becomes the highest, when each characteristic quantity which constitutes a vector follows a normal distribution. Therefore, since the feature of the pattern expressed by the vector is chosen by the original feature space, as compared with the case where the feature number of dimension is compressed, the amount of operations decreases by space conversion.

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EXAMPLE

[Example] Hereafter, the example of this invention is explained with a drawing.
[0012] Drawing 2 shows the system configuration of one example of this invention.
[0013] The system shown in this drawing consists of the feature-extraction section 10, the order-of-approximation calculation section 11, the selection-criterion determination section 12, the feature-selection section 13, and the low dimension-ized feature storing section 14.
[0014] Hereafter, operation of the above-mentioned composition is explained.
[0015] Drawing 3 is a flow chart for explaining the outline of operation of one example of this invention.
[0016] Step 10 First, the feature-extraction section 10 extracts characteristic quantity from two or more inputted training patterns, expresses it by the feature vector, and is inputted into the order-of-approximation calculation section 11.
[0017] The degree of approximation with the degree calculation section 11 of step 11 approximation close [the distribution of the characteristic quantity of each dimension expressed by the feature vector extracted at Step 11 / which] to a normal distribution is calculated using statistical indexes, such as skewness and kurtosis, for every characteristic quantity.
[0018] The step 12 selection-criterion determination section 12 determines independent or the selection criterion of the feature which should combine, should use and should be chosen for the degree of approximation called for at Step 11. [two or more]
[0019] If a step 13 strange pattern is inputted into the feature-extraction section 10, characteristic quantity will be extracted, and it will express by the feature vector, and will input into the feature-selection section 13.
[0020] The step 14 feature-selection section 13 chooses the feature vector of a strange pattern based on the selection criterion determined in the selection-criterion determination section 12 in the feature vector extracted at Step 13.
[0021] The step 15 low dimension-ized feature storing section 14 stores the low feature vector of a number of dimension among the feature vectors of the strange pattern chosen in the feature-selection section 13.
[0022] The processing for determining the selection criterion in the selection-criterion determination section 12 here is explained. The kurtosis, the skewness, and N training pattern characteristic quantity vector quantity which were asked for the selection-criterion determination section 12 in the degree calculation section 11 of approximation are inputted. Here, it is the characteristic quantity vector of N training patterns inputted X1 = (x11, x12, ..., x1i, .., x1m)
X2 = (x21, x22, ..., x2i, .., x2m)
.. XN = (xN1, xN2, ..., xNi, .., xNm)
When it carries out, it can ask for the skewness and kurtosis of the i-th feature by the following formulas respectively.
[0023]
[Equation 2]

歪度：

$$A_i = (1/N) \sum_j \{(x_{ij} - \mu_i) / S_i\}^3$$

尖度：

$$B_i = (1/N) \sum_j \{(x_{ij} - \mu_i) / S_i\}^4$$

[0024] N shows the number of training patterns among the above-mentioned formulas, xij shows the i-th characteristic quantity of the j-th training pattern, and it is mui. The average of the i-th characteristic quantity of a training pattern is shown, and it is Si. The standard deviation of the i-th characteristic quantity of a training pattern is shown.
[0025] When each element of a vector follows a normal distribution, skewness is set to 0.0 and kurtosis is set to 3.0. a center [average] -- carrying out -- a distribution -- the left -- a value negative in skewness when distorted -- taking -- reverse -- the right -- it becomes a positive value in being distorted Moreover, it is known that acute [of the center of a distribution] will increase as kurtosis becomes large.
[0026] When skewness and kurtosis are given, the selection-criterion determination section 12 calculates the value used as the criteria for determining the selection feature based on these values as a selection criterion, and outputs the feature number to choose to the feature-selection section 13.
[0027] As criteria which choose the feature in the feature-selection section 13, it is the absolute value of a difference with the value of skewness [in / - normal distribution / for example,]. : a=|A-0.0| (3)
And absolute value of a difference with the value of the kurtosis in - normal distribution: b=|B-3.0| (4)
The feature of the fixed individual chosen from the direction with few values c which calculate them based on the following (5) formulas by carrying out linear combination of the values a and b in the feature of the fixed individual chosen from the

smaller one of the sum of the ranking at the time of attaching ranking or (3), and (4) formulas from the one where the feature of the fixed individual chosen from the direction with few values at the time of ******(ing) and the value of a and b are smaller etc. can be considered.
[0028]
C=alphaa + betab (5)
Here, alpha and beta are parameters with a suitable value.
[0029] The feature-selection section 13 memorizes the selection feature number (selection criterion) determined by the selection-criterion determination section 12, and chooses the feature vector of the strange pattern actually inputted into the feature-extraction section 10 based on it. If the m-dimensional feature vector extracted from the strange pattern in the feature-extraction section 10 is inputted into this feature-selection section 13, the feature will be chosen in accordance with the selection criterion called for by the selection-criterion determination section 12, and a n-dimensional feature vector (m>n) will be outputted to the low dimension-ized feature storing section 14.
[0030] The low dimension-ized feature storing section 14 stores the feature of the strange data formed into the low dimension by doing in this way. For example, a 8-dimensional vector as shown below is inputted, and it is Xin. = (x1, x2, x3, x4, x5, x6, x7, and x8)
Xout =(x1 ,x2 ,x5 ,x8)
When memorizing in the feature-selection section 13 as a feature which 1, 2, and the 5 or 8th feature should choose, the 4-dimensional feature is outputted to the low dimension-ized feature storing section 14.
[0031] The low dimension-ized feature storing section 14 stores the feature (x1, x2, x5, and x8).
[0032] In addition, when a new training pattern is given, the feature can always be chosen in the optimal state by performing re-calculation of kurtosis and skewness, and reconfiguration of the feature decision criteria (selection criterion).
[0033] As mentioned above, in accordance with a selection criterion, an effective thing is chosen from the features expressed by the vector of the inputted strange pattern, and the class to which this is formed into a low dimension and a strange pattern belongs is determined.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is principle explanatory drawing of this invention.
[Drawing 2] It is the block diagram of one example of this invention.
[Drawing 3] It is a flow chart for explaining the outline of one example of this invention.
[Description of Notations]
10 Feature-Extraction Section
11 Approximation Calculation Section
12 Selection-Criterion Determination Section
13 Feature-Selection Section
14 The Low Dimension-ized Feature Storing Section

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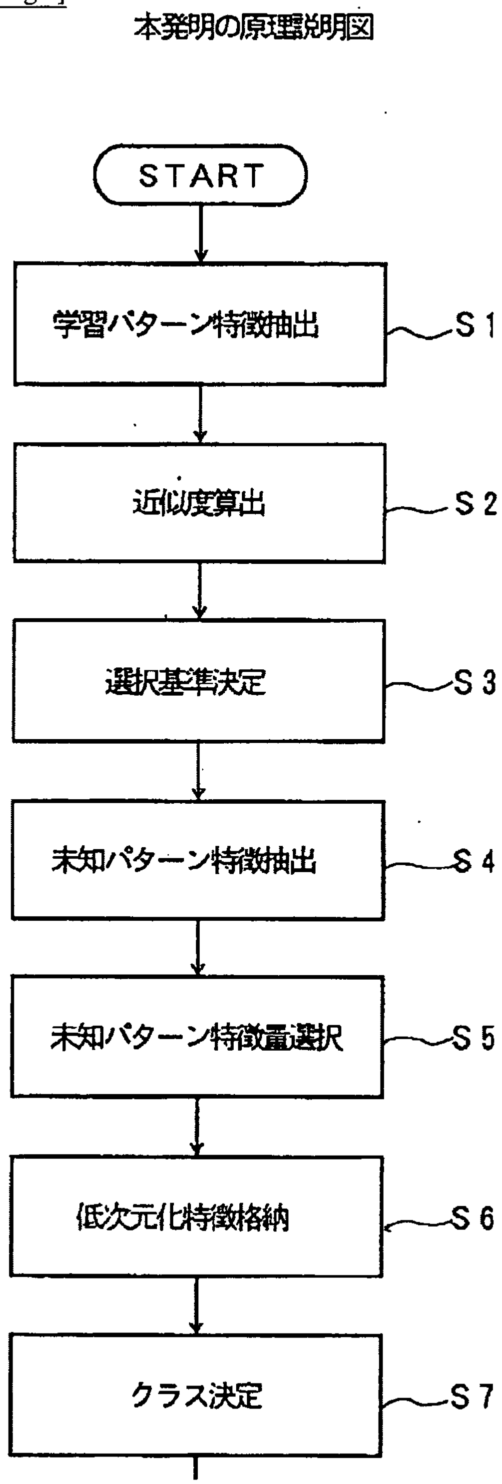
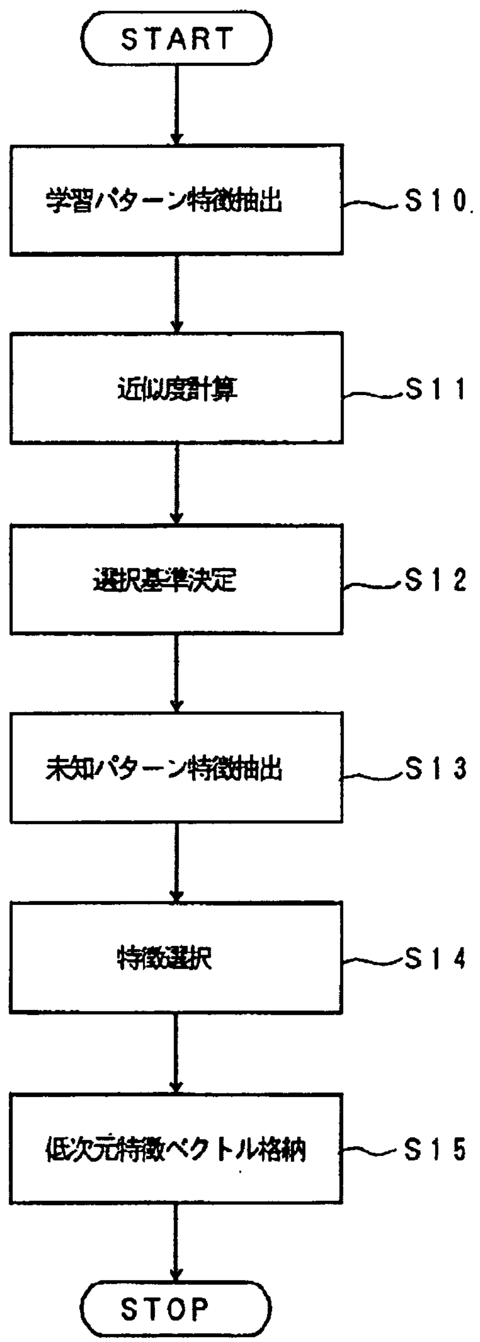
DRAWINGS

[Drawing 1]



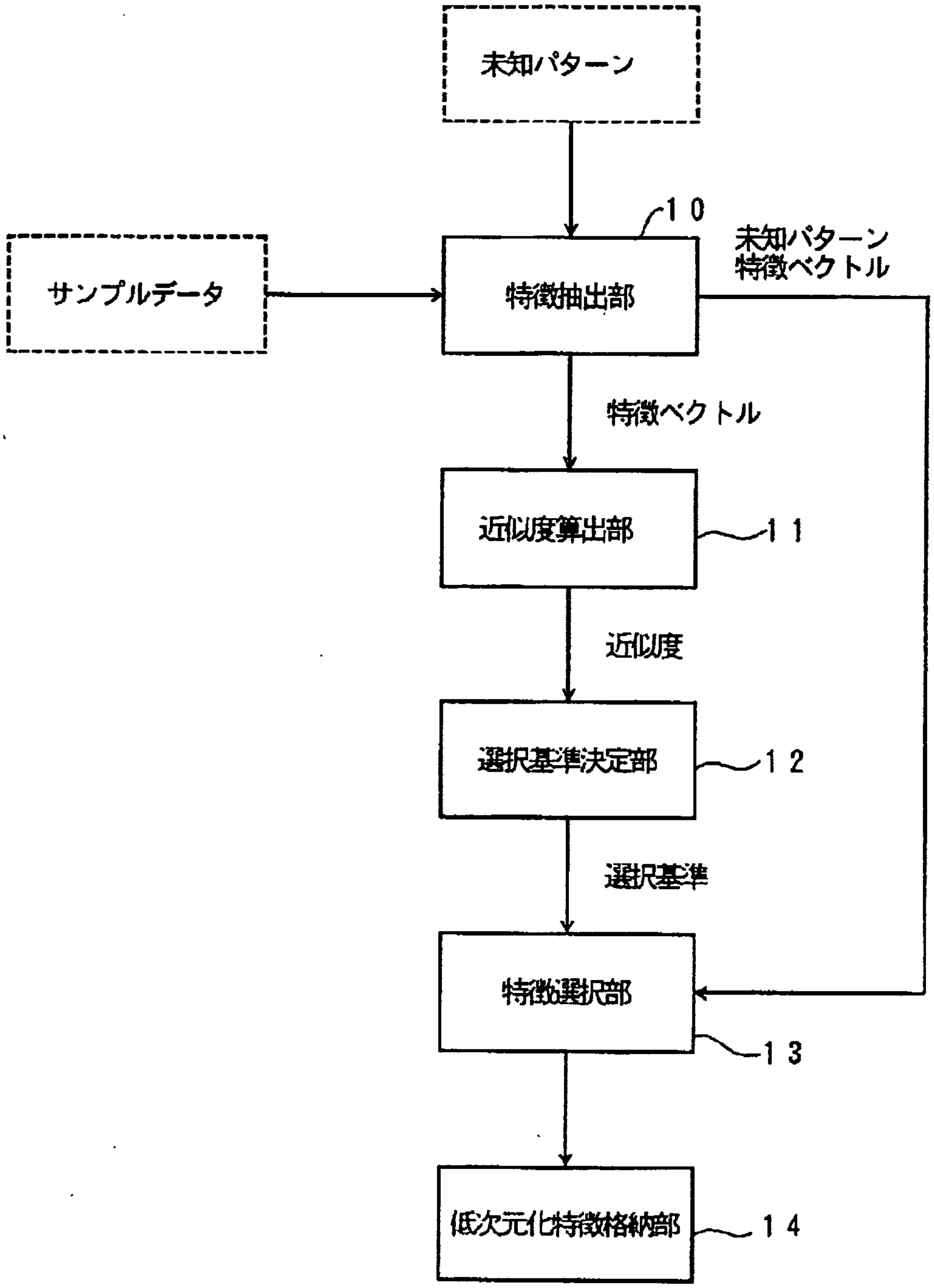
[Drawing 3]

本発明の一実施例の動作の概要を示すフローチャート



[Drawing 2]

本発明の一実施例の構成図



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		9061-5L	G06F 15/70	460 B	
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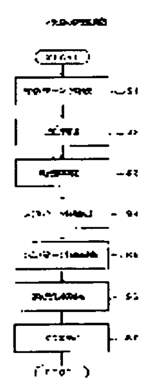
(74)代理人 弁理士 [illegible]

(54)【発明の名称】 特徴選択方法

(57)【要約】
【目的】 本発明の目的は、パターンの属するクラスを決定する際の距離計算の積和計算の演算量を少なくすることができる特徴選択方法を提供することである。
【構成】 本発明は、複数の学習パターンから特徴ベクトルを抽出し（ステップ１）、統計的指標により近似度を求め（ステップ２）、選択すべき特徴量の選択基準を決定し（ステップ３）、未知パターンの特徴ベクトルを抽出し（ステップ４）、ステップ４で抽出された未知パターンの特徴ベクトルを選択基準に基づいて選択し（ステップ５）、得られた次元数の低い特徴ベクトルを格納し（ステップ６）、未知パターンの属するクラスを決定する（ステップ７）。



【特許請求の範囲】

【請求項１】 複数個の特徴量でベクトル表現されたパターンの属するクラスを決定する場合に、ベクトルで表現された各特徴の中で有効なものを選択し、特徴ベクトルを低次元化してパターンの属するクラスの決定を行う特徴選択方法において、
複数の学習パターンから特徴ベクトルを抽出し、
各クラスの属する複数個のパターンの全部または一部についての特徴ベクトルの次元毎の値の分布を求め、該分布が正規分布にどれだけ近いかの近似度を１つ以上の統計的指標によって求め、
該近似度を単独で、または組み合わせて用いることにより選択すべき特徴量の選択基準を決定し、
未知パターンの特徴ベクトルを抽出し、
抽出された未知パターンの特徴ベクトルを該選択基準に基づいて選択し、得られた次元数の低い特徴ベクトルを格納することを特徴とする特徴選択方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、特徴選択方法に係り、特に、複数個の特徴量でベクトル表現されたパターンの属するクラスを決定する際に、ベクトルで表現された各特徴の中から複数個の特徴を選択し、低次元のベクトルでクラスの決定を行う特徴選択方法に関する。

【０００２】

【従来の技術】従来、入力された未知パターンが属するクラスを決定する際に、学習パターンによって予め作成された辞書と未知パターンとの距離を求める過程において、複数個の学習パターンから得られる特徴ベクトルの共分散行列を用いて主成分分析を行い、空間変換を行って固有値の大きい高次の成分のみを距離計算に用いることにより、特徴の次元数を圧縮する手法が知られている。

【０００３】即ち、一般にm次元特徴ベクトル
x＝（x1，x2，…………，xm）t
があったとき、ベイズの識別関数
D（X）＝（X－μ）tS-1（X－μ）－1n｜S｜
は、

【０００４】

【数１】

$$D(X)=\sum_{i=1}^{m}(\phi_i{}^{t}(X-\mu))^2/\lambda_i-\ln|S|$$

【０００５】と等価であり、通常はここでの固有値λの低次元成分を取り除くことによって、変換後の空間での特徴の次元数の圧縮を図り、演算量を低減している。ここで、Sは共分散行列、μは平均ベクトル、φは固有ベクトル、λは固有値である。

【０００６】

【発明が解決しようとする課題】しかしながら、上記従来の手法は、次元圧縮を行う際に、空間変換のために上記（１）で示すように積和計算を行う必要があり、この計算に伴う演算量が大きいという問題がある。

【０００７】本発明は、上記の点に鑑みなされたもので、上記従来の問題点を解決し、パターンの属するクラスを決定する際の距離計算の積和計算の演算量を少なくすることができる特徴選択方法を提供することを目的とする。

【０００８】

【課題を解決するための手段】図１は、本発明の原理説明図である。

【０００９】本発明は、複数個の特徴量でベクトル表現されたパターンの属するクラスを決定する場合に、ベクトルで表現された各特徴の中で有効なものを選択し、特徴ベクトルを低次元化してパターンの属するクラスの決定を行う特徴選択方法において、複数の学習パターンから特徴ベクトルを抽出し（ステップ１）、各クラスに属する複数個のパターンの全部または一部についての特徴ベクトルの次元毎の値の分布を求め、該分布が正規分布にどれだけ近いかの近似度を１つ以上の統計的指標によって求め（ステップ２）、近似度を単独で、または組み合わせて用いることにより選択すべき特徴量の選択基準を決定し（ステップ３）、未知パターンの特徴ベクトルを抽出し（ステップ４）、ステップ４で抽出された未知パターンの特徴ベクトルをステップ３で決定された選択基準に基づいて選択し（ステップ５）、得られた次元数の低い特徴ベクトルを格納し（ステップ６）、未知パターンの属するクラスを決定する（ステップ７）。

【００１０】

【作用】本発明は、ベクトルを構成する各特徴量が正規分布に従うとき、ベイズの識別関数による識別精度が最高になる性質を利用して、ベクトルの次元毎の特徴量の分布が正規分布に近いもののみを有効な特徴として選択し、その選択された特徴を用いることにより、空間変換を行わないまま、原特徴空間で距離計算を行うものである。従って、ベクトルで表現されたパターンの特徴を原特徴空間で選択するので、空間変換によって特徴次元数を圧縮する場合と比較して演算量が少なくなる。

【００１１】

【実施例】以下、本発明の実施例を図面と共に説明する。

【００１２】図2は、本発明の一実施例のシステム構成を示す。

【００１３】同図に示すシステムは、特徴抽出部１０、近似度算出部１１、選択基準決定部１２、特徴選択部１３及び低次元化特徴格納部１４より構成される。

【００１４】以下、上記の構成の動作を説明する。

【0015】図3は、本発明の一実施例の動作の概要を説明するためのフローチャートである。
【0016】ステップ10）まず、特徴抽出部10は、入力された複数個の学習パターンから特徴量を抽出し、特徴ベクトルで表現し、近似度算出部11に入力する。
【0017】ステップ11）近似度算出部11は、ステップ11で抽出された特徴ベクトルで表現された各々の次元の特徴量の分布がどれだけ正規分布に近いかの近似度を、例えば、特徴量毎に歪度、尖度等の統計的指標を用いて計算する。
【0018】ステップ12）選択基準決定部12は、ステップ11で求められた近似度を単独または、複数組み合わせて用い、選択すべき特徴の選択基準を決定する。
【0019】ステップ13）未知パターンが特徴抽出部10に入力されると、特徴量を抽出し、特徴ベクトルで表現し、特徴選択部13に入力する。
【0020】ステップ14）特徴選択部13は、ステップ13で抽出された特徴ベクトルを選択基準決定部12で決定された選択基準に基づいて未知パターンの特徴ベクトルを選択する。
【0021】ステップ15）低次元化特徴格納部14は、特徴選択部13で選択された未知パターンの特徴ベクトルのうち、次元数の低い特徴ベクトルを格納する。
【0022】ここで、選択基準決定部12における選択基準を決定するための処理を説明する。選択基準決定部12は、近似度算出部11で求められた尖度と歪度とN個の学習パターン特徴量ベクトル量が入力される。ここで、入力されるN個の学習パターンの特徴量ベクトルを

$X1=(x_{11}, x_{12}, \ldots\ldots, x_{1i}, \ldots\ldots, x_{1m})$

$X2=(x_{21}, x_{22}, \ldots\ldots, x_{2i}, \ldots\ldots, x_{2m})$

・

・

$XN=(x_{N1}, x_{N2}, \ldots\ldots, x_{Ni}, \ldots\ldots, x_{Nm})$

としたとき、第i番目の特徴の歪度と尖度は各々以下の式により求めることができる。

【0023】

【数2】

歪度：

$$A_i = (1/N)\sum\{(x_{ji}-\mu_i)/S_i\}^3$$

尖度：

$$B_i = (1/N)\sum\{(x_{ji}-\mu_i)/S_i\}^4$$

【0024】上記の式のうち、Nは、学習パターン数を示し、x_{ji}は、第j番目の学習パターンの第i番目の特徴量を示し、μ_iは、学習パターンの第i番目の特徴量の平均値を示し、S_iは、学習パターンの第i番目の特徴量の標準偏差を示す。
【0025】ベクトルの各要素が正規分布に従うとき、歪度は0．0、尖度は3．0となる。平均を中心として、分布が左歪の場合には、歪度は負の値をとり、逆に右歪の場合には、正の値となる。また、尖度が大きくなるに従い分布の中央の尖鋭さが増大することが知られている。
【0026】選択基準決定部12は、歪度と尖度が与えられたとき、これらの値に基づいて選択特徴を決定するための基準となる値を選択基準として計算し、選択する特徴番号を特徴選択部13に出力する。
【0027】特徴選択部13において、特徴を選択する基準としては、例えば、

・正規分布における歪度の値との差の絶対値：

$$a=|A-0.0| \quad (3)$$

及び

・正規分布における尖度の値との差の絶対値：

$$b=|B-3.0| \quad (4)$$

を計算した場合の値の少ない方から選択した一定個の特徴、a，bの値の小さい方から順位を付した場合の順位の和の小さい方から選択した一定個の特徴、あるいは、（3）、（4）式における値a，bを以下の（5）式に基づいて線形結合して計算する値cの少ない方から選択した一定個の特徴などが考えられる。

【0028】

$$c=\alpha a+\beta b \quad (5)$$

ここで、α、βは適当な値をもつパラメータである。
【0029】特徴選択部13は、選択基準決定部12により決定された選択特徴番号（選択基準）を記憶し、それに基づいて、実際に特徴抽出部10に実際に入力された未知パターンの特徴ベクトルの選択を行う。特徴抽出部10で未知パターンから抽出されたm次元の特徴ベクトルがこの特徴選択部13に入力されると、選択基準決定部12により求められた選択基準に従って特徴を選択し、n次元特徴ベクトル（m＞n）を低次元化特徴格納部14に出力する。
【0030】低次元化特徴格納部14は、このようにして低次元化された未知データの特徴を格納する。例えば、以下に示すような8次元ベクトルが入力され、
$Xn=(x1, x2, x3, x4, x5, x6,$

x7, x8)

Xαt=(x1, x2, x5, x8)

1、2、5、8番目の特徴が選択すべき特徴として特徴選択部13で記憶されている場合は、4次元の特徴が低次元化特徴格納部14に出力される。

【0031】低次元化特徴格納部14は、特徴(x1, x2, x5, x8)を格納する。

【0032】なお、新たな学習パターンが与えられた時に、尖度、歪度の再計算や、特徴決定基準(選択基準)の再設定を行うことにより、常に最適の状態で特徴を選択することができる。

【0033】上記のように、入力された未知パターンのベクトルで表現された特徴の中から選択基準に沿って有効なものを選択し、これを低次元化して未知パターンの属するクラスを決定する。

【0034】

【発明の効果】上述のように、本発明によれば、複数の特徴量で表現されるベクトルデータをクラス分類する際に用いる特徴を本来の特徴空間で選択するので、空間変換を行う必要がなく、未知パターンの属するクラスを決定する際の距離計算の積和演算の量を少なくすることができる。

【図面の簡単な説明】

【図1】本発明の原理説明図である。

【図2】本発明の一実施例の構成図である。

【図3】本発明の一実施例の概要を説明するためのフローチャートである。

【符号の説明】

10 特徴抽出部

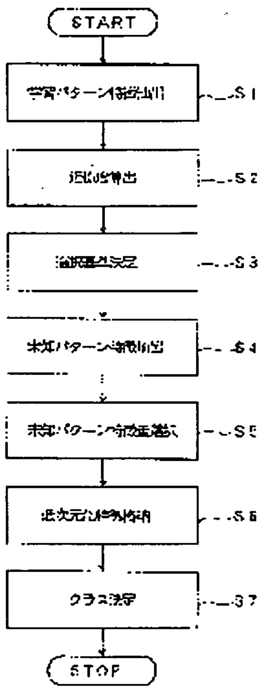
11 近似算出部

12 選択基準決定部

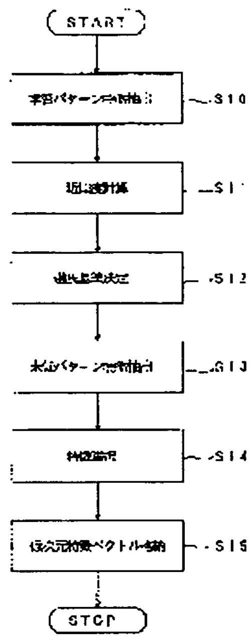
13 特徴選択部

14 低次元化特徴格納部

【図1】



【図3】



【図２】

本発明の一実施例の構成図